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REVIEWS.

THE GEOLOGY OF WYOMING.*—The first part contains a geological itinerary, while the second part is more general in its nature, containing chapters giving a general view of the geology of the Missouri Valley, of the region between Omaha and Cheyenne, the route over the first range, the Laramie Plains and westward to Bear River, and onward to the Great Salt Lake Valley, closing with a chapter giving a general review of the geology of the country from Omaha to Salt Lake Valley, and a final chapter on the mines, etc.

Prof. Hayden's explorations are extended over an immense extent of country, and while the work is our only authoritative guide to the geological and agricultural capabilities of this important area, even these preliminary reports throw a flood of light on the geological history not only of the American Continent, but we may venture to add that of the globe and the succession of life on its surface. In illustration we quote as follows:—

“That there is a connection between all the coal beds of the far West I firmly believe, and I am convinced that in due time that relation will be worked out and the links in the chain of evidence joined together. That some of the older beds may be of upper Cretaceous age I am prepared to believe, yet until much clearer light is thrown upon their origin than any we have yet secured, I shall regard them as belonging to my transition series or beds of passage between the true Cretaceous and the Tertiary.

When the large collections of fossil plants from the West now in the possession of Dr. Newberry are carefully studied, we shall have a much better basis upon which to rest a conclusion. It will be seen at once that one of the most important problems in the geology of the West awaits solution, in detecting, without a doubt, the age of the coal series of the West, and the exact line of demarcation between the Cretaceous and Tertiary periods.

The study of this question shows the importance of the continued accumulation of facts and the collection of organic remains. Neither can we place too rigid reliance on the teachings of the fossils, for it has already been shown many times that the fauna

*Preliminary Report of the U. S. Geological Survey of Wyoming, and portions of contiguous territories (being a second annual report of progress). By F. V. Hayden, U. S. Geologist. Washington, 1871. 8vo, pp. 511.

and flora of the Tertiary deposits of this country, when compared with those of the Old World, reach back one epoch into the past. We have already obliterated the chasm between the Permian and the Carboniferous era, and shown that there is a well-marked insculcation of organic forms—those of supposed Permian affinities passing down into well-known Carboniferous strata, and admitted Carboniferous types passing up into the Permian. We believe that the careful study of these transition beds is destined to obliterate the chasm between the Cretaceous and Tertiary periods, and that there is a passing down into the Cretaceous period of Tertiary forms, and an extending upward into the Tertiary of those of Cretaceous affinities. It appears also, that every distinct fauna or flora of a period ought to contain within itself the evidence of its own age or time of existence, with certain prophetic features which reach forward to the epoch about to follow. If there is a strict uniformity in all the operations of nature when taken in the aggregate, as I believe there is, then this is simply in accordance with the law of progress which in the case of the physical changes wrought out in the geological history of the world has operated so slowly that infinite ages have been required to produce any perceptible change. The position that I have taken, in all my studies in the West, is that all evidences of sudden or paroxysmal movements have been local and are to be investigated as such, and have had no influence on the great extended movements which I have regarded as general, uniform and slow, and the results of which have given to the West its present configuration. The splendid group of fossils obtained on the Upper Missouri, from the Fox Hills Group or upper Cretaceous beds, illustrates the prophetic element I have mentioned above. Among them are many true Cretaceous forms, as *Ammonites*, *Baculites*, *Inoceramus*, etc., yet these all present such a modern facies that they seem plainly to look forward into the succeeding epoch, which in the case of our Atlantic coast was strictly marine. It was no fault of the fossils themselves that they were mistaken in this instance."

Prof. Hayden's remarks on the relation of the Quaternary period to the Tertiary are of much interest:—

"As we have previously remarked, we believe that the Quaternary period, although more difficult to study, will be found to be scarcely second in importance to any of the previous great epochs in geology. A careful study of these modern deposits will undoubtedly show consecutive links by which it was united to the Tertiary period, in the same manner as the Cretaceous and Tertiary are connected in the case of the great Tertiary lake now indicated by the deposits on White and Niobrara Rivers, in Nebraska, in which the waters continued to cover a greater or less area through most of the Quaternary period, at least, as is shown by the thick

deposits of fine sand, with bones of mammals and shells of existing species, on Loup Fork and its tributaries. The same may be said of the bluff deposit, or loess, which is so well displayed along the Missouri from Fort Pierre down below St. Louis, and probably, to the Gulf of Mexico. At a modern period it is probable, that the waters of the ocean swept high up inland, reaching nearly to the foot of the mountains. The great water-courses had already been marked out, consequently we find the yellow marl or loess fifty to one hundred and fifty feet thick in the immediate valley of the Missouri, but thinning out as we recede from it, or the valleys of any of its branches. The existence of so many fresh-water mollusca and the entire absence of any marine forms indicate that the waters of the Mississippi and Missouri were either cut off from the direct access to the sea, or that the influx of such a vast quantity of fresh water as must have flowed down from the mountain districts rendered completely fresh the inland portions.

We may suppose the temperature just prior to the present period to have been extremely low, and that the elevated portions of the West were covered with vast masses of snow and ice; that as the temperature became warmer this snow and ice melted, producing such an accession to the already existing waters that they covered all the country excepting, perhaps, the summits of the highest peaks; that masses of ice filled with fragments of rocks, worn and unworn, floated off into this great sea, and melting, scattered the contents over the hills and plains below; that as the waters diminished these masses of ice would accumulate on the summits of the foot-hills of the mountains, or at certain localities in the plains; and thus account for the great local accumulations of stray rocks at certain places. The materials also which must have been removed from all portions of the West drained by the Missouri and its tributaries by surface denudation, as is illustrated by the "bad lands", etc., were also swept into this vast inland lake, and then carried beyond the reach of currents, would settle quietly to the bottom, almost without lines of stratification, as we observe in the loess. The last act was the recession of these waters to their present position, and the formation of the terraces. We believe the terraces constitute the last change of any importance in the surface of the western continent. We suppose that the channels of all the streams on the eastern slope of the Rocky Mountains were at one time occupied with water from hill to hill, and that the drainage was toward the sea. But in the Great Basin, which so far as we know has no outlet, the drainage must have been by evaporation, for the evidence points to the conclusion that it was entirely filled with water high up on the sides of the mountains. There is greater uniformity in the terraces in the Great Basin than in the valley of the Missouri, which indicates a far more equable drainage. Still, those along the flanks of the Wasatch Mountains number two or three principal ones, but these

formations separate into five or six; and Stansbury mentions one locality where there are ten or twelve of them. In the Missouri Valley and along the eastern slope generally, the terraces vary much in height and importance.

The distant hills are composed of the yellow marl or loess, and the surface has been weathered into the rounded, conical hills. This portion is often covered with the drift or stray rocks, or what I have called in a former report the erratic block deposit. On the terraces these erratic masses are scarcely ever found, and in the broad bottoms of the Missouri River seldom if ever. This fact strengthens the opinion that the terraces are really one of the latest features, and that they were formed during the drainage of the waters toward the sea after the temperature had reached nearly its present state. Oscillations of level may have contributed somewhat to the formation of the terraces, but I am inclined to believe that the drainage or the contraction of the waters is the main cause. This is an important point, and I hope hereafter to treat it more fully when I have accumulated a greater number of facts. It has been my belief for years, that not only the Missouri River but all the branches, from the largest river like the Yellowstone or Platte that flowed into it to the smallest creek that has cut its cañon deep into the sides of the mountains, were once filled with water from side to side, but have gradually shrunk to their present diminutive proportions. All over the West are large dry beds which must have at one time given passage to vast bodies of water. The flanks of the mountains, from the north line to Mexico are gashed with gullies or cañons, many of which are now dry as the dusty road for the greater portion of the year. I mention some of these details here simply to show how closely the story of the physical growth of our western continent is linked together, and that it needs only the careful, conscientious grouping together of the facts to secure this history step by step from the earliest commencement to the present time, and mould it into one harmonious whole."

Any one with geological proclivities about to take a trip across the continent over the Pacific Railroad should by all means read this interesting sketch of the country between Omaha and Salt Lake.

The third part contains a report by Prof. C. Thomas on the agriculture of the Territory, with notes on the grasshoppers, especially the Western Locust (*Caloptenus spretus*.)

Part IV. contains a preliminary paleontological report by Prof. F. B. Meek, with reports on the Tertiary coals of the West, by James T. Hodge; on the ancient lakes of Western America, their deposits and drainage, by Prof. J. S. Newberry (which will be

found at p. 641 vol. IV of this journal) ; on the vertebrate fossils of the Tertiary formations of the West, by Prof. J. Leidy ; on the fossil plants of the Cretaceous and Tertiary formations of Kansas and Nebraska, by L. Lesquereux ; on the fossil reptiles and fishes of the Cretaceous rocks of Kansas, the fossil fishes of the Green River group and the recent reptiles and fishes obtained by the naturalists of the Expedition, by Prof. E. D. Cope ; and finally, a report on the Industrial Resources of Western Kansas and Eastern Colorado, by R. S. Elliott.

These reports contain matter of much general interest by the distinguished scientists whom Prof. Hayden has summoned to his aid, and give the volume a lasting value. From Mr. Lesquereux's report we select the following remarks on the discordance in the characters of the European and American flora of the Tertiary and Cretaceous epochs :—

“ Since the first appearance of land vegetation upon the surface of our earth, what we know of it by fossil remains seems to indicate for our country a precedence in time in the development of botanical types. Large trunks of coniferous wood are already found in our Devonian measures, while analogous species are recorded as yet only in the Carboniferous measures of England. Though the analogy of vegetation between the flora of the coal measures of America and Europe is evidently established by a number of identical genera and species, we have nevertheless some types like the *Paleoxiris*, which are considered as characteristic of strata of the European Permian, and which are found in our coal measures as far down as the first coal above the millstone grit. Even peculiar ferns of our upper coal strata have a typical analogy with species of the Oölite of England. Our Trias, by the presence of numerous Cycadeæ, touches the Jurassic of Europe. But it is especially from our flora of the lower Cretaceous that we have a vegetable exposition peculiarly at variance with that of Europe at the same epoch and whose types so much resemble those of the European Tertiary that the evidence of the age of the formation, where the plants have been found, could not be admitted by paleontologists until after irrefutable proofs of it had been obtained.”

Prof. Cope's report gives glimpses of the reptilian life which formerly flourished over this region :—

“ The species of reptiles which have been found in the Cretaceous strata west of the Mississippi River up to the present time number fourteen. Five of these pertain to the *Sauropterygia*, one to the *Dinosauria*, and seven to the *Pythonomorpha*. In the present report attention is confined to the species discovered near the line

of exploration of Dr. Hayden, or that of the Kansas Pacific Railroad, and that of Professor B. F. Mudge of the State Agricultural College.

During the period when the Cretaceous ocean extended from Eastern Kansas over the present site of the Rocky Mountains, and from the Gulf of Mexico to the Arctic Sea, it abounded in life. Among vertebrata, fishes and marine reptiles chiefly abounded, and in varied forms. Many of the reptiles were characterized by a size and strength exceeding that seen in any other period of the world's history. The species of *Sauropterygia* and *Pythonomorpha* were all aquatic, but the two types present very different adaptations to their mode of life. While the former possessed two pairs of limbs the latter appear to have possessed an anterior pair only, or with the posterior pair so reduced as to have been insignificant. They substituted for them an immensely long and flattened tail, which they used, like the eels and sea-snakes, as an oar. The *Sauropterygia* were generally stout-bodied and with a very markedly distinct neck. In the *Pythonomorpha*, on the other hand, the body was snake-like, with narrow chest and neck scarcely differing in diameter. They were immensely elongate, and might be called sea-serpents with considerable propriety.

Of *Sauropterygia*, *Polycotylus* had a slender neck and very stout limbs; but in *Elasmosaurus* the neck attained dimensions exceeding that of any vertebrated animal. The species *E. platyrus* was probably the longest of the order, measuring perhaps fifty feet, but of this the neck amounted to twenty-two feet. The creature was carnivorous, and could no doubt like the snake-bird, swim at a considerable distance below the surface of the water and reach to the surface for air, or explore the depths or plunge for fishes to the depth of forty feet.

Among the *Pythonomorpha* the *Liodon dyspelor* is the largest species and the *Clidastes intermedius* the smallest. A specimen of *Mosasaurus Missuriensis* obtained by William Webb near Topeka is stated by him to measure seventy-five feet in length. Should this be substantiated the *L. dyspelor* was at least one-third larger. This is, however, as yet uncertain.

The upper arm bones of the *Clidastes* are remarkably short and wide and furnished with strong processes for the insertion of muscles. They are among reptiles much like those of moles among quadrupeds, and, as in the latter, indicate probably great power of propulsion in the fore limbs. The finger bones were long and slender and formed a long fin or flipper, while the upper arm was probably concealed in the skin. The whole limb came off but a short distance posterior to the head. These reptiles, so far as known were all carnivorous; their food was chiefly fishes."

His notes on the fossil fishes are of much interest:—

"The laminated rock from which the above species were ob-

tained is similar in general appearance to the clay beds of Mount Lebanon and Mount Bolca. The first indication of the existence of this deposit was brought by Dr. Jno. Evans, who obtained from it a clupeoid, which was described by Dr. Leidy as *Clupea humilis* (Proc. Acad. Nat. Sci. Phila., 1856, p. 256). One of the blocks contains the remains of two shoals of the fry, probably of *C. humilis*, which were caught suddenly by a slide or fall of calcareous mud, and entombed for the observation of future students. They must have been taken unawares, since they lie with their heads all in one direction as they swam in close bodies. One or two may have had a moment's warning of the catastrophe, as they have turned a little aside, but they are the exceptions. The fry are from one-half to three-quarters of an inch long and upward.

True herring, or those with teeth, are chiefly marine, but they run into fresh waters and deposit their spawn in the spring of the year, and then return to salt waters. The young run down to the sea in autumn and remain there till old enough to spawn. The size of the fry of the Rocky Mountain herring indicates that they had not long left the spawning ground, while the abundance of adults suggests they were not far from salt water, their native element. To believe, then, that the locality from which these specimens were taken was neither far from fresh, nor far from salt waters is reasonable; and this points to a tide, or brackish inlet or river. The species of *Cyprinodontidæ* inhabit also tide and brackish waters. Most of the species of the family as well as of the genus, are inhabitants of fresh water; but they generally, especially the cyprinodons proper, prefer still and muddy localities, and often occur in water really salt. This habitat distinguishes them especially from Cyprinidæ (minnows and suckers) and pike. Lastly, the known species of *Osteoglossum* inhabit fresh waters.

The material which composes the shales indicates quiet water, and not such as is usually selected by herring for spawning in; while the abundance of adult Clupeas indicate the proximity of salt water.

This is far from a satisfactory demonstration of the nature of the water which deposited this mass of shales, but is the best that can be obtained with such a meager representation of species.

As to geological age the indications are rather more satisfactory. The genus *Clupea* ranges from the Upper Eocene upward, being abundant in the slates of Lebanon and Monte Bolca, while *Cyprinodon* has been found in neither, but first appears in the middle or lower Miocene in Europe. The *Asineops* resemble very closely, and I believe essentially the *Pygæus* of Agassiz of Eocene age, from Monte Bolca. The peculiarities presented by the genus found by Dr. Hayden are of such small significance as to lead me to doubt the beds in question being of later than Eocene age, though the evidence rests chiefly on this single, new and peculiar genus.

The position of these fishes, seven thousand feet above the level of the sea, furnishes another illustration of the extent of elevations of regions once connected with the ocean, and the comparatively late period of geologic time at which, in this case, this elevation took place."

If we find so much of interest and novelty in the preliminary report, how much has our science in store when the final report and its illustrations appear!

GEOGRAPHICAL DISTRIBUTION OF THE BEETLES.*—In this exceedingly interesting and suggestive essay, the author divides the Coleoptera of the world into three great "stirps," or assemblages:—the Indo-African, the Brazilian, and what for want of a better name he calls the "microtypal" stirps; the species composing it "being of a smaller size, or, more strictly speaking, not containing such large or conspicuous insects as the others." Thus all but the tropical, even including the Australian insects, are considered as belonging to this mass of small forms. "The coleopterous fauna of our own land [Great Britain] may be taken as its type and standard."

We very much question whether this division be not too artificial to be generally received by zoologists. The primary distribution of faunæ corresponding to the polar, temperate and tropical regions, would seem to be the more philosophical, being based on climatic causes.

Mr. Murray believes that the diffusion of animals and plants by accidental means "bears no important part in the establishment of any definite fauna or flora." He thinks that actual continuity of soil and subsequent isolation alone produce faunæ with a definite character. While he thinks these changes of surface took place before the Tertiary period, and does not believe that the new Atlantis, to take a case in point, existed during that period, yet he is one of the most ultra in the school of writers on geographical distribution who take up and put down continents like checkermen. Thus the Azores, Canary Islands and St. Helena, Ascension Island, St. Paul and Tristan d'Acunha, are to Mr. Murray the relics of a former continent, when the Atlantic was dry land, and Europe and America ocean beds. He puts down a

*On the Geographical Relations of the Chief Coleopterous Fauna. By Andrew Murray. Extracted from the Linnæan Society's Journal.—Zoology, vol. XI, London, 1871. 8vo. pp. 89.